

Planck 2015 results: XVII. Constraints on primordial non-Gaussianity

Ade P., Aghanim N., Arnaud M., Arroja F., Ashdown M., Aumont J., Baccigalupi C., Ballardini M., Banday A., Barreiro R., Bartolo N., Basak S., Battaner E., Benabed K., Benoît A., Benoit-Lévy A., Bernard J., Bersanelli M., Bielewicz P., Bock J., Bonaldi A., Bonavera L., Bond J., Borrill J., Bouchet F., Boulanger F., Bucher M., Burigana C., Butler R., Calabrese E., Cardoso J., Catalano A., Challinor A., Chamballu A., Chiang H., Christensen P., Church S., Clements D., Colombi S., Colombo L., Combet C., Couchot F., Coulais A., Crill B., Curto A., Cuttaia F., Danese L., Davies R., Davis R., De Bernardis P., De Rosa A., De Zotti G., Delabrouille J., Désert F., Diego J., Dole H., Donzelli S., Doré O., Douspis M., Ducout A., Dupac X., Efstathiou G., Elsner F.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2016 ESO. The Planck full mission cosmic microwave background (CMB) temperature and E-mode polarization maps are analysed to obtain constraints on primordial non-Gaussianity (NG). Using three classes of optimal bispectrum estimators-separable template-fitting (KSW), binned, and modal-we obtain consistent values for the primordial local, equilateral, and orthogonal bispectrum amplitudes, quoting as our final result from temperature alone $\text{localNL} = 2.5 \pm 5.7$, $\text{equiNL} = -16 \pm 70$, $\text{fNL}_{\text{local}} = 2.5 \pm 5.7$, $\text{fNL}_{\text{equil}} = -16 \pm 70$, and $\text{orthoNL} = -34 \pm 32$, $\text{fNL}_{\text{ortho}} = -34 \pm 33$ (68% CL, statistical). Combining temperature and polarization data we obtain $\text{fNL}_{\text{local}} = 0.8 \pm 5.0$, $\text{fNL}_{\text{equil}} = -4 \pm 43$, and $\text{fNL}_{\text{ortho}} = -26 \pm 21$, $\text{localNL} = 0.8 \pm 5.0$, $\text{equiNL} = -4 \pm 43$, and $\text{orthoNL} = -26 \pm 21$ (68% CL, statistical). The results are based on comprehensive cross-validation of these estimators on Gaussian and non-Gaussian simulations, are stable across component separation techniques, pass an extensive suite of tests, and are consistent with estimators based on measuring the Minkowski functionals of the CMB. The effect of time-domain de-glitching systematics on the bispectrum is negligible. In spite of these test outcomes we conservatively label the results including polarization data as preliminary, owing to a known mismatch of the noise model in simulations and the data. Beyond estimates of individual shape amplitudes, we present model-independent, three-dimensional reconstructions of the Planck CMB bispectrum and derive constraints on early universe scenarios that generate primordial NG, including general single-field models of inflation, axion inflation, initial state modifications, models producing parity-violating tensor bispectra, and directionally dependent vector models. We present a wide survey of scale-dependent feature and resonance models, accounting for the "look elsewhere" effect in estimating the statistical significance of features. We also look for isocurvature NG, and find no signal, but we obtain constraints that improve significantly with the inclusion of polarization. The primordial trispectrum amplitude in the local model is constrained to be $\text{glocalNL} = (-0.9 \pm 7.7) \times 10^4$ (68% CL statistical), and we perform an analysis of trispectrum shapes beyond the local case. The global picture that emerges is one of consistency with the premises of the Λ CDM cosmology, namely that the structure we observe today was sourced by adiabatic, passive, Gaussian, and primordial seed perturbations.

Keywords

Cosmic background radiation, Cosmology: observations, Cosmology: theory, Early Universe, Inflation, Methods: data analysis